

Full-Bayesian Estimation of Spatio-temporal Models of Relative Suicide Risk in Japan

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1 Introduction

1.1 Important Properties of Suicide Death Data

- count data of rare events aggregated in time and space
 - Poisson models
- small area statistics and (temporal/spatial) dependency
 - Bayesian methods
- Underlying socio-economic factors

1.2 Aims

We obtain preliminary results from statistical analyses of spatio-temporal variation of suicide mortalities. We use count data at middle-level aggregation in space and time: secondary medical service area, 5yrs. Spatial/temporal dependency and socio-economic covariate effects are taken into account in modelling suicide risk. Finally, we examine a suitable model by model selection statistics.

2 Our Approach

We use a full Bayesian approach to model differential changes in suicide death by secondary medical service areas in Japan and time (1988-2007). R and WinBUGS are used for MCMC sampling.

2.1 Basic Set-up

Assume that crude suicide death rate in area i and its age group k can be represented by

$$R_{i,k,t} = \theta_{i,t} \cdot R_{s,k,t}$$

where $R_{s,k,t}$ is the crude suicide death rate in the reference population and its age group k and $\theta_{i,t}$ is the relative suicide risk in area i , and, in addition, that

$$O_{i,k,t} | R_{i,k,t} \sim \text{Pois}(N_{i,k,t} \cdot R_{i,k,t})$$

where $O_{i,k,t}$ is the suicide death count in area i and age group k and $N_{i,k,t}$ is area i 's population. We then have

$$O_{i,t} | \theta_{i,t} \sim \text{Pois}(E_{i,t} \cdot \theta_{i,t}), \quad \text{cond. indpt. over } i.$$

2.2 An Example of Selected Models

We fitted 14 models (Model A-N) and their variants with the choice of covariates. Three main types of these models are: spatially-dependent random-effect models, persistence models, and covariate models. For instance, Model N is

$$(2.1) \quad Z_{i,t} = \log \theta_{i,t} = \mu + \gamma_i t + s_i + U_{i,t} + \beta_t X_{i,t},$$

where

$$\mathbf{P}(s_i | \sigma_s^2) \propto \sigma_s^{-N} \exp \left[-\frac{1}{2\sigma_s^2} \sum_{j < i} v_{ij} (s_i - s_j)^2 \right],$$

is an ICAR-type spatially-structured random effect and

$$(2.2) \quad \gamma_i \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(\gamma, \sigma_{\gamma \cdot u}^2), \quad \sigma_{\gamma \cdot u}^2 \sim \mathcal{IG}(0.001, 0.001)$$

is an exchangeable spatial random coefficient of linear trend, and

$$U_{i,t} \stackrel{\text{i.i.d.}}{\sim} \mathcal{N}(0, \sigma_U^2), \quad \sigma_U^2 \sim \mathcal{IG}(0.001, 0.001)$$

is an exchangeable spatio-temporal random effect, and where

$$\beta_t = \beta_{t-1} + \omega_t$$

with

$$\begin{aligned} \beta_1 &\sim \mathcal{N}(0, V), & \text{for } t = 1 \\ \beta_t &\sim \mathcal{N}(\beta_{t-1}, \sigma_\beta^2), & \sigma_\beta^2 \sim \mathcal{IG}(0.001, 0.001), \quad \text{for } t > 1. \end{aligned}$$

3 Results

A summary of results will be presented in the poster session.

Selected References

- Congdon, P. (2000). Monitoring Suicide Mortality: A Bayesian Approach, *European Journal of Population*, **16**, 251-284.
- Congdon, P. (2006). *Bayesian Statistical Modelling*, 2nd ed., John Wiley & Sons, Ltd.
- Gilks, W.R., *et al.* (1996). *Markov Chain Monte Carlo in Practice*, Chapman & Hall/CRC.
- Lawson, A. B., *et al.* (2000). Disease mapping models: an empirical evaluation. Disease Mapping Collaborative Group, *Statistics in Medicine*, **19**, 2217-41.
- Roberts, G. O. and J. S. Rosenthal (2004). General State Space Markov Chains and MCMC Algorithms, *Probability Surveys*, **1**, 20-71.